Work and Energy
Pre-AP Seventh Grade Science
2011-2012

Description

Energy is not lost or used up, but can be transferred from one object to another by doing work. When work is done, a force has been applied, resulting in the movement of an object over a distance. The amount of force required to move the object is directly proportional to the object's mass and is explained by Newton's Second Law of Motion. Energy is required to produce the force needed to move the object, and the object's kinetic energy is changed when the object is moved. Energy can be calculated using standard formulas, and may also be graphically represented. Kinetic energy is directly proportional to the square of the speed and to the mass. Emphasis is placed on observing interactions of moving objects, the forces involved, and the energy transferred. Also emphasized is predicting how changing the size of the force and the distance over which the force acts relates to the amount of energy transferred. Force and motion can be represented by vectors which show magnitude and direction of motion or of the force applied. Students understand that energy is conserved.

Connections

Energy as it relates to force and motion also relates to living organisms. Transfer of energy from chemical energy to heat and thermal energy during digestion, as well as forces that affect motion in everyday life such as emergence of seedlings, turgor pressure (relating to plant vacuoles), and geotropism (caused by hormonal changes in the plant), will be covered in a later unit on cellular structure and function.

Enduring Understandings

1. Energy is transferred when work is done.
2. Work occurs when force is applied on an object and there is a displacement parallel to the direction of the force. No work is done unless there is a displacement in the same direction as the applied force.
3. Distance and displacement are not equal. Distance is the total path traveled and displacement is the difference between the start and end points. Only when travel is in a straight line are distance and displacement equal.
4. Energy is required to exert a force, and force is required to initiate or change an object's motion. Forces only exist as a result of an interaction between two objects.
5. The force required to move an object is directly proportional to the object's mass. As mass increases, the force required to move that mass also increases (Newton's Second Law).
6. When applied force changes, the energy of the object receiving the force changes.
7. Changes in force may affect the amount of extension (stretch) in an elastic body.
8. Kinetic energy describes an object in motion. The kinetic energy of an object depends on an object's mass and how fast the object is moving. The more mass an object has, the more energy it has, and the faster an object is moving, the more energy it has.
9. Energy, work and force may be calculated and represented by numerical values.
10. Interactions of objects may be represented by vector diagrams which show magnitude and direction.
11. Energy may be transformed or transferred, but is never lost.

Essential Questions

1. What is work and how is it calculated?

2. How is distance different than displacement?
3. What factors affect how much work is done?
4. What is force and how is it calculated?
5. What factors affect how much force is applied?
6. How do changes in force affect work, energy, and motion?
7. What is kinetic energy and how is it calculated?
8. What factors affect how much kinetic energy an object has?
9. What factors influence the direction of motion?
10. How can vectors be used to represent the force and motion of interacting objects?
11. What is elastic energy?
12. How is energy transferred?
13. What does it mean to conserve energy?

Essential Concepts and Skills

By the end of the unit, the student is expected to:

1. distinguish between distance and displacement
2. measure and calculate work
3. classify examples as work or non-work
4. describe and give examples of Newton's Second Law of Motion
5. measure and calculate force
6. predict how changing the energy transferred to an object would change the object's force
7. predict how changes in force affect the total amount of work done
8. calculate kinetic energy
9. predict how changes in velocity and mass affect the total amount of kinetic energy an object has
10. measure and calculate elastic energy
11. discover variables which change the direction of motion
12. justify why energy is changed or transferred but never lost
13. produce vector diagrams to show the interaction of objects in motion with vectors showing magnitude and direction

What do students typically have as misconceptions?

1. The terms "energy" and "force" are interchangeable.
2. Doubling the speed of a moving object doubles the kinetic energy.
3. Energy can be "used up."
4. The motion of an object is always in the direction of the net force applied to the object.
5. The terms distance and displacement are synonymous and may be used interchangeably

Preconception Survey

1. What is work?
2. Are force and energy the same? Explain.
3. What happens to energy when a moving object comes to a stop?
4. What happens to kinetic energy when speed increases?

Formative Assessment Items

1. Justify why some real-world examples show work and some show non-work
2. Measure displacement and force, and calculate work using real-world scenarios to prove the difference between work and non-work

3. Rank real-world examples of work in terms work done, and verify that the rankings were correct using mathematical calculations
4. Find the speed and calculate the kinetic energy of rolling marbles of different sizes
5. Create vector diagrams of colliding marbles to show transfer of energy
6. Describe in words what happens to energy when marbles collide
7. Explore variables that affect the motion of marbles after force has been applied
8. Measure the elastic energy in an object and relate it to a real-world example
9. Justify why no energy has been lost even though colliding marbles have stopped moving

<u>TEKS Covered</u>

7.7 Force, motion, and energy. The student knows that there is a relationship among force, motion, and energy. The student is expected to:

A) contrast situations where work is done with different amounts of force to situations where no work is done such as moving a box with a ramp and without a ramp, or standing still. ***Supporting Standard-Category 2***

B) illustrate the transformation of energy within an organism such as the transfer from chemical energy to heat and thermal energy in digestion.

C) demonstrate and illustrate forces that affect motion in everyday life such as emergence of seedlings, turgor pressure, and geotropism.

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6.8 Force, motion, and energy. The student knows force and motion are related to potential and kinetic energy. The student is expected to:

A) compare and contrast potential and kinetic energy ***Supporting Standard-Category 2***

C) calculate average speed using distance and time measurements ***Supporting Standard- Category 2***

D) measure and graph changes in motion ***Supporting Standard-Category 2***

6.9 Force, motion, and energy. The student knows that the Law of Conservation of Energy states that energy can neither be created nor destroyed, it just changes form. The student is expected to:

C) demonstrate energy transformations such as energy in a flashlight battery changes from chemical to electrical energy to light energy ***Supporting Standard-Category 2***

<u>College Board Standards Covered</u>

PS-PE.4.1.1 Give real-world examples of mechanical interactions in which there are changes in the elastic energy (e.g., a stretched rubber band or a compressed rubber ball) of one of the interacting objects.

PS-PE.4.1.2 Describe, using words and a representation, the transfer of energy in different situations involving chains of mechanical interactions (e.g., the object acting as the energy receiver during the first interaction is the object acting as the energy source during the next interaction).

PS-PE.4.1.3 Given a real-world situation involving an interaction between two objects defined as a system:

PS-PE.4.1.3a Observe changes in each object during the interaction.

PS-PE.4.1.3b Make a claim about the direction of the energy transfer. Justification is based on observations of which object is acting as the energy source and which object is acting as the energy receiver.

PS-PE.4.1.3c Represent the energy transfer and the energy changes within the system.

PS-PE.4.1.4 Explain, predict and represent how changing the size of the force or the distance over which the force acts changes the amount of mechanical energy transferred during the interaction.

Vocabulary
mass, force, work, speed, energy, displacement, vector, velocity, kinetic energy, potential energy, chemical energy, mechanical energy, elastic energy, thermal energy, Newton's Second Law of Motion